AMERICAN SOCIETY OF CIVIL ENGINEERS.

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TRANSACTIONS.

NOTE.—This Society is not responsible, as a body, for the facts and opinions advanced in any of its publications.

CCXLVI.

(Vol. XI.—October, 1882.)

PRESERVATION OF TIMBER.

Preliminary Report of the Committee on the Preservation of Timber, made to the Society at the Annual Convention, May 16th, 1882. The Report is accompanied by a paper upon the Application of Kyanizing at Fort Ontario, New York, by WILLIAM P. JUDSON, Member Am. Soc. C. E., and by letters from J. B. FRANCIS, Past President Am. Soc. C. E.; from J. W. HOBART, Gen. Supt. Central Vermont R.R.; from HUGH RIDDLE, President, and M. ALEXANDER, Road Master, Chicago, Rock Island and Pacific R. R.; from J. W. PUTNAM, Assoc. Member Am. Soc. C. E.; and from M. G. HOWE, Member Am. Soc. C. E.

With Discussion of the Subject by MENDES COHEN, A. GOTTLIEB, T. EGLESTON, J. B. FRANCIS, C. HERSCHEL, Members Am. Soc. C. E., and E. R. ANDREWS, Assoc. Member Am. Soc. C. E.

PRELIMINARY REPORT

Of the Committee on "Preservation of Timber," made to the Society at the Annual Convention, May 16th, 1882.

Your Committee on the Preservation of Timber is enabled to report good progress, but not at this time to make a final report.

It has already gathered a large mass of information concerning past experience (chiefly failures) in this country, but it finds such serious discrepancies concerning the results of apparently the same processes, that it requires more time to complement the data that have been gathered.

The unpleasant revelations of the last census (1880) concerning the proximate extinction of many of the forests which have hitherto been so bountifully productive, make it apparent that the time cannot be far distant when our people will have to stop the waste of timber which has been going on, and resort, for many purposes, to the artificial preservation of wood against decay.

Several such methods have proved successful in Europe, and are there generally used. In this country failure has been the rule, even where the same processes were nominally adopted. One of the principal problems, therefore, which your Committee had to solve, was to account for this divergency of experience, so as to ascertain, if possible, the causes of past failures, the defects of the various processes, and the conditions which must be observed to ensure success.

In order to base its report upon ascertained facts, your Committee determined to gather, as fully as practicable, the results of past experience in this country in the preservation of wood, and to enter into communication with all those persons who might be ascertained to possess information on the subject.

With this in view the Committee issued the following circular:

AMERICAN SOCIETY CIVIL ENGINEERS,
127 EAST 23D STREET,
NEW YORK, January 23d, 1882.

SIR,—Appreciating that the rapid destruction of timber in this country gives increasing importance to its artificial preparation against decay, the American Society of Civil Engineers has appointed a Committee to report upon "The preservation of timber."

It is said that while success has been accomplished abroad, failure or partial failure has, until recently, been the rule in the United States, so that consumers of timber are generally distrustful of all methods for preserving it.

The Committee, therefore, first desires to obtain information concerning past experience (and especially concerning failures) in this country,

in order to ascertain whether the failure, or the success, was due to the preserving agent selected, to the quantity injected, or to the method of applying it.

It issues this circular to find out where this information can be obtained.

Will you be kind enough to answer upon the enclosed postal card, the following questions ?

1st.—Do you know about, or can you ascertain the result of past experiments in preserving wood in this country ?

Answer.....

2d.—If so, where and when were they made ?

Answer.....

.....

3d.—Kindly give us the name and address of persons who can furnish further information on this subject.

Answer.....

.....

While the Committee wishes to intrude as little as possible upon the time of busy men, even on a subject of such general importance, it will gladly receive all the information and documents you may choose to send in this connection.

Please address all communications to O. Chanute, Chairman, Box 839, New York City.

Please keep this Circular and Card in a conspicuous place until you have answered it.

With this was enclosed a postal card, addressed to the chairman, containing the three printed questions and space for their answer.

About 1000 of these circulars have, up to the present time, been sent out, addressed to civil engineers, railroad superintendents, timber dealers and chemists.

Thus far 151 of these postal cards have been returned, 90 of them containing valuable information, and giving the addresses of other parties who are familiar with experiments.

To these various parties 160 letters have been written, representing correspondence with 95 different persons, asking for the particulars of their experience, and containing upon the form of letter sheet used the following foot-note, directing attention to the kind of information particularly wanted :

"NOTE.—The 'Committee on the Preservation of Timber,' earnestly "solicits information concerning past experience in the impregnation "and preservation of timber in this country, more particularly that con- "cerning failures.

"Parties will give the description of processes and results in their "own way, but they are requested to bear the following points in mind, "in order to assist the Committee in reaching general conclusions : 1st. "Kinds and dimensions of timber operated on. 2d. Its condition, green "or dry. 3d. Its preparation for injection. 4th. Preserving ingredient "injected. 5th. Its quantity per cubic foot, or per tie. 6th. Method "of injection. 7th. Time occupied. 8th. Subsequent use and exposure "of timber, (bridges, buildings, track). 9th. Results as to duration. "10th. Comparison with life of unprepared timber. 11th. Effect on the "strength and hardness of the prepared timber. 12th. Your general "conclusions."

This correspondence, together with some 30 pamphlets which have been gathered by the committee, and personal interviews with whatever parties were accessible, have furnished more or less information concerning 88 experiments, representing some 33 different processes, of which the following is a list :

EXPERIMENTS IN AMERICA.

LOCALITY.	DATE.	PROCESS.	MATERIAL.
Ft. Ontario, Oswego, N. Y....	1839	Kyan.....	Timber.
Lowell Canal Co., Mass.....	1848	"	"
Syracuse & Utica R.R.....	1849	"	Ties.
Fitchburg R.R., Mass.....	1853	Kyan.....	Flooring.
Phila. & Reading R.R.....	1855	"	Bridges.
Northern Central R.R.....	1838	"	Ties.
Alexandria Aqueduct.....	1840	"	Superstructure.

Locality.	Date.	Process.	Material.
Lowell Canal Co., Mass.....	1850	Burnett.....	Timber.
Vermont Central R.R.....	1856	"	Ties.
Erie R.R.....	1861	"	Bridges, &c.
C., R. I. & P. R.R.....	1866	"	Ties.
Havre de Grace, P. W. & B..	1866	"	Bridge.
Lehigh & Susquehanna.....	1867	"	Ties.
Ft. Point, Cal.....	1876	Thilmany (old).....	Piles.
Charlestown, Mass.....	1877	" (old).....	Timber.
Wabash R.R.....	1877	" "	Ties.
Phila. & Reading.....	1867	Burnett.....	"
Norfolk Navy Yard.....	1876	Thilmany (new).....	Piles.
Flushing, L. I.....	.....	Burnett.....	Stringers.
Cleveland & Pittsburgh.....	1870	Thilmany (old).....	Ties.
Charleston, S. C.....	.....	" "	Piles.
Taunton, Gt. River, Mass....	1865	Creosote.....	"
St. Clair Flats, Mich	1868	Seely.....	Timber.
C., R. I. & P. R.R.....	1868	Creosote.....	Ties.
Pittsburgh City.....	1872	Seely.....	Paving.
Staten Island Battery.....	1871	"	Gun Platforms.
Ft. Tompkins.....	"	"	" "
Battery Hudson.....	"	"	" "
Staten Island Mortar Battery.	"	"	" "
" " Battery Hudson	"	"	" "
" " Mortar Battery.	"	"	" "
Ft. Moultrie, S. C.....	"	"	" "
Ft. Sumter, S. C.....	"	"	" "
Ft. Pulaski, Ga.....	"	"	" "
Ft. Moultrie, S. C.	1873	Bethell.....	" "

Locality.	Date.	Process.	Material.
Ft. Sumter, S. C.	1873	Bethell	Gun Platforms.
N. Cliff Battery, N. Y.	"	"	" "
Ft. Pulaski, Ga.	"	"	" "
Ft. Jackson, Ga.	"	"	" "
Ft. Jefferson, Dry Tortugas	"	Creosote	" "
Callowhill, St. Br., Phila.	18—	"	Flooring.
G. C. & St. F. R.R., Texas	1875	"	Piles.
Galveston City, Texas	"	"	Paving.
Bound Brook, N. J.	1876	"	Ties.
Central R.R of New Jersey	"	Bethell	"
M. & N. O. R.R., Chef Menteur	"	Creosote	" Piles, &c.
Hoboken, N. J.	1878	Hayford	Piles.
Delaware Bay	"	"	"
Boston, Mass.	"	"	Fence Posts.
Hoboken	1880	"	Piles.
New Orleans Gas Co.	"	Creosote	Ties and Piles.
Houston & Texas R.R.	"	"	" "
Phila. & Reading R.R.	18—	Hayford	Ties.
East River Bridge		Bethell	Caisson.
Cleveland City	1873	Carbolizing	Paving.
Ft. Point, Cal.	1870	Robbins	Piles.
C., B. & Q. R. R., N. Bost. Br.	1868	Coal Tar	Ties.
Phila. & Reading R.R.	1854	" "	"
Bangor, Maine	1872	Lime and Salt	Timber, &c.
Phila. & Columbia R.R.	1840	Salt	Stringers.
Belvedere R.R.	1850	"	"
Blackstone Br., N. Y. & N. E.	1854		Bridge.
Flushing, L. I.			Ties.
Union Pacific	1872		"

Locality.	Date.	Process.	Material.
Union Pacific	1868		Bridge.
Erie R.R.	1858	Boring out centre	Bridges.
C., B. & Q. R.R., Aurora	1870		
Pensacola, Fla.	1874	Thilmany (old)	Piles.
Indiana		Charring	Fence Posts.
Eastern R.R.	1846	Kyanizing	Ties, &c.
Washington	1872	Waterbury	Paving Blocks.
"	"	Thomas	" "
"	"	Detwiler & Van Guilder	" "
"	"	Wirt & Hurdle	" "
"	"	Keystone Paving Co.	" "
"	"	Vulcanizing	" "
"	"	Samuels	" "
"	"	Tait	" "
"	"	Taylor's	" "
"	"	Thompson & Co	" "
"	"	A. B. Tripler	" "
"	"	Foremanizing	" "
"	"	Beerizing	" "
"	"	U. S. Antiseptic Co.	" "
Cleveland, O.	1873	Creosote	Paving.
"	"	Thilmany	"
Boston, Columbus Ave.	1869	Creosote (Paul)	"
Chili	1858	Boucherie	Ties.

The information concerning these various experiments is, however, quite fragmentary and incomplete. Many of the statements contradict each other, and before sound conclusions can be drawn, more data must be obtained, and the evidence will have to be carefully sifted.

The Committee, therefore, desires more time, in order to conduct the

inquiry with that care which its importance demands; and to investigate the matter thoroughly before forming any conclusions. This it hopes to do during the coming year, and to report either at the annual meeting or the next annual convention.

The Committee earnestly solicits the aid of all members of the Society, as well as that of any person possessing information on the subject. It will be particularly grateful for old pamphlets and reports on wood preservation, and will give due credit to those who may furnish information.

Meanwhile, in order to give the Society an idea of the kind of information which it is possible to obtain, the Committee begs to submit the following contributions which it has received, concerning three of the more successful processes now used for the preservation of timber:

1st. A valuable paper by Mr. W. P. Judson, United States Assistant Engineer, Member of the Society, upon the application of Kyanizing at Fort Ontario, New York.

2d. A letter from Mr. J. B. Francis, Past President of the Society, giving an account of his experience in Kyanizing,

3d. A letter from Mr. J. W. Hobart, General Superintendent of the Central Vermont Railroad, stating the experience of that road in Burnettizing.

4th. A letter from Mr. Hugh Riddle, President of the Chicago, Rock Island and Pacific Railroad, enclosing a report from Mr. M. Alexander, Roadmaster, concerning experiments on that line in Burnettizing and creosoting.

5th. A report from Mr. J. W. Putnam, member of this Committee, on creosoting on the Mobile and New Orleans Railroad.

6th. A letter from Mr. M. G. Howe, Member of the Society, concerning creosoting on the Houston and Texas Central Railway.

Respectfully submitted,

O. CHANUTE, Chairman, New York,
B. M. HARROD, New Orleans,
G. BOUSCAREN, Cincinnati,
E. R. ANDREWS, New York,
E. W. BOWDITCH, Boston,
COL. G. H. MENDELL, San Francisco,
C. SHALER SMITH, St. Louis,
J. W. PUTNAM, New Orleans,

Committee.

PAPERS ACCOMPANYING THE REPORT

OF THE

COMMITTEE ON THE PRESERVATION OF TIMBER.

LETTER FROM J. B. FRANCIS, PAST PRESIDENT, AM. SOC. C. E.:

O. CHANUTE, Esq.,

Chairman of the Committee of the Am. Soc'y of Civil Engrs. on the Preservation of Timber.

DEAR SIR,—In reply to your circular of January 23d, last, I have to say: That the process for the preservation of timber from rapid decay, called Kyanizing, has been carried on here, under my direction, since 1848. As conducted here, it is simply the immersion of the timber for a period of time, depending on its thickness, in a solution of corrosive sublimate, namely, one pound of corrosive sublimate in one hundred pounds of water; for boards one inch in thickness, two days immersion is allowed, and an additional day for each additional inch in the least thickness.

John Howard Kyan's patent was taken out in England, March 31, 1832, and it was also patented in the United States. The effect of corrosive sublimate in preventing putrefaction had long been known, and its application to prevent the decay of timber was favorably received.

Professor Faraday delivered a lecture upon it before the Royal Institution, and it was extensively used by Brunel and others, and a company called the Anti Dry Rot Company established works where timber, canvas and cordage were Kyanized. In the United States it was used by several Railroad Co's. At Lowell, the need of some means of preventing the rapid decay of timber was strongly felt, it being extensively used in bridges over the canals and about the factories in situations favorable to decay, and leading to much expense and inconvenience, from its frequent renewal.

In England, Kyanizing appears to have been entirely superseded by the process patented by John Bethell, July 11, 1838, commonly called creosot-

ing, which consists in saturating the timber with an oil obtained by distillation from coal tar; this oil contains a proportion of creosote, which is a powerful antiseptic, and is supposed to be the active ingredient in preventing decay.

Kyanizing, first used here in 1848, was continued about two years, when Burnettizing was substituted, being a cheaper, more expeditious, and said to be an equally effective process. This was patented in England by Sir William Burnett, July 26, 1838, and is similar to Kyanizing, except that the antiseptic is chloride of zinc, instead of corrosive sublimate.

Burnettizing was continued here until about 1862, when it had become apparent that it was less effective than Kyanizing, and we returned to that process, which is still continued.

In 1862, I obtained specimens of various kinds of timber in common use in this neighborhood; each specimen was originally about fifteen feet long and nine inches square; it was cut into two equal lengths, and one part Kyanized and the other part retained in its natural state. In April, 1863, they were all set out in the ground as posts, the prepared and unprepared specimens side by side, where they have remained until now. If thought desirable, I can have them taken up and examined, and a statement prepared of the condition of each. I observe that one of your Committee is Mr. E. W. Bowditch, of Boston. I should be happy to show him, or any other member of the Committee, the specimens, and give him all the information in my power on the subject.

Perhaps, all I need say now is, that although Kyanizing does not completely prevent the decay of wood in exposed situations, our experience of more than thirty years, has satisfied us, that the benefits derived from it far exceed the cost of the process.

I send you by this mail a pamphlet relating to Burnettizing, printed while we had full confidence in it, and I shall be happy to furnish, either personally or by letter, any further information in my power, relating to either of the processes.

Very truly yours,

JAMES B. FRANCIS.

LOWELL, MASS.,
March 18, 1882.

LETTER FROM J. W. HOBART, ESQ., GEN. SUPT. CENTRAL VERMONT RAILROAD.

ST. ALBANS, VT., April 28th, 1882.

O. CHANUTE, Esq.,

127 East 23d Street, New York, N. Y. :

DEAR SIR,—In reply to your favor of the 25th instant, I would say : That in 1856, this road erected works for the purpose of extracting sap from wood and of infusing chemicals for the purpose of preservation. It was in use some four years, but it was so much work to get through with such large quantities of timber as are used upon a railroad, that it was thought best to abandon the work ; therefore, the boiler and fixtures were removed and sold, and nothing more was thought of the "Burnettizing" process until some three years since, when an old side track was removed, which had not been in use for several years, and which was nearly covered with earth and grass, still the hemlock ties were then found to be nearly sound, having laid there for nearly 25 years. I did not keep watch of other prepared timber put in at that early time, and as repairs are constantly going on upon a railroad, I am unable to say whether there are any other similar cases upon our line or not, but there is no doubt that the preservation of these ties was due to the process above named.

The reasons for abandoning the Burnettizing works upon this road would seem to be, that the officers in charge at that time lost faith in the theory, and as it was an experiment, they did not learn of its value until recently discovered in the manner referred to. There is no question, in my opinion, regarding the value of the process.

Yours very truly,

J. W. HOBART,
Genl. Supt.

LETTER FROM HUGH RIDDLE, ESQ., PRESIDENT CHICAGO, ROCK ISLAND AND PACIFIC RAILWAY.

OFFICE OF THE PRESIDENT. CHICAGO, March 24, 1882.

O. CHANUTE, Esq.,

Chairman, &c. :

DEAR SIR,—In reference to the experiments made by this company in treating ties and timber with preservatives, I enclose copy of a letter

from Mr. M. Alexander, in reply to inquiries made by me, that gives his experience and views as to ties treated by two different processes. I will add that Mr. Alexander has been connected with this road, as road-master and engineer, for 25 years or more, and his statements may be taken as coming from one who knows of what he speaks. I will add further that we have a Howe truss bridge of 8 spans of 150 feet each, erected in the fall of 1860 (the timbers of which were Burnettized) that is still in use and in fair condition; but we intend to rebuild this season.

Yours truly,

HUGH RIDDLE.

REPORT OF M. ALEXANDER, ESQ., ROADMASTER AND ENGINEER CHICAGO, ROCK ISLAND AND PACIFIC R'Y.

BLUE ISLAND, ILL, March 23, 1882.

H. RIDDLE, Esq.,

Pres't C., R. I. & P. R'y:

DEAR SIR,—In reply to your letter of March 15, asking for dates, &c., regarding ties that have been subjected to different kinds of treatment and laid in track on the C., R. I. & P. R'y, I can only give you the results of two lots of ties that have been treated, one of which are Burnettized and the other creosoted.

November, 1866, we laid in main track just west of Englewood about 2 000 soft-wood ties, consisting of pine, tamarack and cedar, but the greater proportion of them were hemlock. These ties were all treated to a solution of chloride of zinc, and have sustained a very heavy traffic. They are laid in a fine gravel ballast, and have received just the same attention that ties have on other parts of the road.

I made a careful examination of these treated hemlock ties last summer, and found at least 75 per cent. of them still in the track, and, in my opinion, in such a state of preservation that they will be serviceable for two or three years longer. Some five or six of these ties were taken out of track and found to be sound and solid in the centre, and only decayed to the depth of ¼ to ¾ of an inch on the surface and sides. The rail has not worn into these hemlock ties to any greater extent than would have occurred with oak, and they hold a spike fully as well as the oak tie. The pine and cedar ties that were Burnettized at the same time

have worn out in the 15 years' service, and have disappeared. The tamarack have held out about the same as the hemlock.

My experience is that untreated hemlock ties decay first in the centre, or heart, when the spike becomes loose, and the tie crumbles; but these treated ties are sound in the centre, which shows that where the chloride of zinc is not washed out the wood is in a perfect state of preservation.

In 1872 we laid in second track, east of Washington Heights, about 5 000 hemlock ties that were subjected to the creosoting process. These ties I do not believe, were thoroughly treated; they seem to be tolerably sound at the bottom, but are badly decayed on the surface, and the rail wears into them to a much greater extent than it does into those that were treated with chloride of zinc. There is probably not more than from 30 to 50 per cent. of these creosoted ties now in track, and these will no doubt all be taken out this season.

I find that the natural life of a hemlock tie, laid in sand or gravel ballast, does not exceed five years; but if thoroughly treated with chloride of zinc, I believe they will last at least fifteen years. The creosoting process, if thoroughly done, will no doubt double the service of soft wood ties.

For any further information I would refer you to M. Lassig, who was in the employ of L. B. Boomer in 1866 and 1867, and who had charge of his Burnettizing works at that time, and subjected large quantities of bridge-timber to treatment.

Respectfully yours,

(Signed) M. ALEXANDER.

LETTER FROM J. W. PUTNAM, ASSOC. MEMBER AM. SOC. C. E.

NEW ORLEANS, LA., April 5, 1882.

O. CHANUTE, Esq.,

Chairman Committee on Preservation of Timber:

DEAR SIR,—I have had a longer and more continuous observation of the deportment of timber on the New Orleans and Mobile Railroad than upon any other road; and my experience and observations and the information gathered from the bridgemen on other roads confirms the results on this road.

An outline history of the use of timber on the New Orleans and Mobile Railroad will therefore apply to most roads in the south which have used the same kinds of timber. There is, however, no record of the time when renewals became necessary or to what extent they were made or the kind of timber used in each year upon any of the structures.

I think such records are kept by some roads, and where they have been continued for a sufficient term of years they would afford valuable data for determining the relative value of different kinds of unpreserved woods.

A large amount of long-leafed yellow pine and quite a quantity of cypress was used in the construction of the road in the years 1869–70. In the year 1874, extensive renewals were required. In 1875–76, still more extensive renewals were demanded.

About the first of March, 1876, the rebuilding of the structures with creosoted timber was commenced and carried forward as rapidly as practicable. As it had been previously determined to rebuild entirely with creosoted timber, only such renewals were made after 1875 as were required for the safety of trains.

The decay was so rapid, especially with the horizontal timber, that in the last bridges rebuilt in 1879, probably not more than five per cent. of the original pine stringers and caps remained. But some of these were sound and would probably have lasted two or three years longer. Some of the timber which had been put in to replace that which first decayed had become so rotten as to require renewal.

The cypress was much better than the yellow pine, and estimating from recollection I think that not more than twenty-five per cent. of the cypress had been removed on account of decay. Black cypress is much the most compact, heavy and durable of any kind that I have used. The red comes next, while the white cypress is but little better than good yellow pine. For cross-ties it is not as good except in straight track, being too soft to hold the spikes and rails.

I think through the Southern States, where there is a long, warm season favorable to fermentation and decay, yellow pine may be expected to last from four to ten years, and red and black cypress from ten to twenty for ordinary trestle bridge work where kept up free from the ground. There is little timber other than pine and cypress suitable for bridge work in this section of country.

The bridge over Chef Menteur was the first to be rebuilt of creosoted

timber, and this was done during the months of March, April and May, 1876. It is an iron truss with spans of 110 feet resting upon pile piers, each pile capped with a cast-iron socket, and the whole surmounted by a wrought girder pier-head upon which the truss rests.

The stringers, cross-ties and guard-rails are of wood.

All the wood-work of the bridge, including piles, was as thoroughly creosoted as practicable, having an average of nearly two gallons of creosote oil per cubic foot.

The bridges over the mouths of Pascagoula River were next built in the months of May, June and July upon the same plan.

During the summer of 1876, several small structures, culverts and water-ways were built entirely of creosoted timber and also a sheet piling revetment along the sides of the embankment across Lake Catharine, which is nearly a half mile long.

This revetment was built of creosoted inch plank, driven double, so as to break joints, and bearing against a wale plank or stringer, supported by piles on the outside.

During the following winter the bridge across the Great Rigolets, nearly three-fourths of a mile long, was built. The piles in these structures are subject to attacks of the *teredo navalis*, especially those at the crossing of the Pascagoula River, where piles a foot and a half in diameter have been cut off by the teredo in a single year. The piles and timber are now perfectly sound, not a piece—as far as I can learn—having shown any indication of decay. Had the timber been put in uncreosoted, there is no doubt that a considerable part would have had to be renewed before this time. How long before decay will commence or how fast it will progress, remains to be seen.

During the summer of 1877 no creosoting was done, but during the fall and winter following a great number of water-ways and trestles and the bridge over Pearl River were built.

Another suspension of creosoting occurred during the yellow fever epidemic of 1878. The work of construction was carried on during the winter following, and finished during the summer of 1879, by the rebuilding of the bridge across Bay Biloxi, one and one-fourth miles long, and across Bay St. Louis, two miles long.

Since then no organization for bridge work has been necessary on the road.

The sandy country through which the road runs makes absolutely

tight culverts or water-ways necessary. These have been built of creosoted timber and placed in the bank so as to allow a covering of earth of from one to twenty feet deep. This gives an unbroken earth-bearing for the cross-ties, and avoids the jump or bouncing motion so often felt in passing open culverts.

Since then a wharf has been built at Ship Island, a foundation put under the lighthouse at Horn Island, and several pieces of work put in on the Mobile and Montgomery Railroad.

Wharves have been and are being built extensively in the Bay of Pensacola, and railroad bridges on the Pensacola and Atlantic Railroad.

Several thousand creosoted piles have been and will be in the waters of this bay, where the teredo is very destructive to timber.

Several piles have been taken out after one or two years, in making changes in wharves, but have been found free from the effects of the *teredo navalis*.

There is a piece of creosoted block-paving in the yard of the New Orleans Gaslight Company which has been in use for nine years. The blocks are perfectly sound and scarcely show any wear, though subjected to the abrasion of all their heavy hauling, carts being used for conveying coke and gas-lime, which carry from three to four thousand pounds.

About ten years ago—I do not know the exact date—a lot of soft, sap pine cross-ties were creosoted and laid on the Galveston and Houston Railroad. They are reported perfectly sound, though such timber, when uncreosoted, is of no comparative value for such work.

There was also a piece of paving laid in a livery stable in Galveston about the same time, which is yet sound.

A large number of piles were creosoted in 1875 for a bridge from Galveston island to the mainland, but as very little oil was used in them, the greater part were soon cut down by the marine animals.

The Houston and Texas Central Railroad are laying a great number of sap pine cross-ties, creosoted, and with, what appear to them to be, very satisfactory results, though they have not been laid long enough to determine their entire durability.

I have several pieces of destructible timber—gum, white birch, beech, willow and elm—which were creosoted in the summer of 1876, and have been lying in the yard, exposed to sun and rain. They are as sound as when cut.

My observations have convinced me that creosoting is valuable in proportion to the amount of oil used, and where practicable, it is advisable to saturate the timber, or, having thoroughly seasoned it and exhausted the air, a body of oil should be forced in sufficient to protect the unimpregnated timber from the fermenting and destructive particles in the air. I do not think the method is known by which compact timber of large size can be thoroughly saturated with any antiseptic material. It is necessary, therefore, to destroy the ferment germs already in the timber and prevent the entrance of others by establishing an impervious coating.

The character of wood seems to be so changed by contact with creosote oil that the ferment germs find no nourishment, and though the oil may have become as thoroughly dried out as possible, no fermentation or decay will take place. No timber should be cut or framed after being creosoted.

I cannot well in this article refer to the different methods of treating timber which have been practiced, not having the data at hand; but if, as Chairman of the Committee, you could have such a compilation made of the various methods which have been put in actual operation, and the results as demonstrated by the durability in service of timber subjected to successive baths of different material, of timber prepared by injecting under pressure an antiseptic preparation either with or without seasoning the timber, and of methods whereby timber is supposed to be saturated by vapors from materials which only vaporize at a temperature far above that to which timber can be raised, it would be valuable for reference. It is not a report of the methods which have been successfully used that alone is wanted, but also of the methods which have been tried and found wanting, to guard others against making the same mistakes.

It seems to me that works for the preservation of timber have been in operation in this country and Europe long enough to make such a compilation extremely valuable, but I have doubts about enough reliable data being gathered by correspondence for such a work.

Yours respectfully,

J. W. PUTNAM.

LETTER FROM M. G. HOWE, MEMBER AM. SOC. C. E.

HOUSTON AND TEXAS CENTRAL RAILWAY.
DIVISION ENGINEER AND SUPT'S OFFICE.
HOUSTON, April 7th, 1882.

To the Committee on Preservation of Timber,
Am. Soc. of Engrs., N. Y.:

GENTLEMEN,—In answer to your communication of March 29th, on the subject of preserving timber, I would say, that the Houston and Texas Central Railway Company has treated about 150,000 cross-ties, and a small quantity of bridge and tank-frame timber with creosote or "dead oil," in the last two years.

Sufficient time has not elapsed for the results to be ascertained on this special work, but enough is known of the effects of "creosote" in preserving similar timber in this climate for a period of eight years to give a good guarantee of success.

The timber used thus far for ties is the short leaf "Texas pine," a porous and perishable wood, that, untreated, will not last more than two years on or in the ground, or exposed to the weather. It takes the oil freely when partially seasoned, and when entirely dry will readily take more than two gallons to the cubic foot. Our works consist of two cylinders 100 feet long, in which the timber is treated, calculated to stand a pressure of 150 pounds per square inch; a superheater, and vacuum and pressure pumps, with suitable steam power and pipe connections, and cisterns for conveying and holding the oil. The process, in brief, is, first, application of superheated steam, then withdrawal of the condensed steam and sap that may have come from the wood, and production of a vacuum, by means of a vacuum pump, the temperature being maintained at the same time by dry heat from the steam pipes, and finally following with the oil at a temperature of about 160 degrees, and with such pressure as may be necessary to produce the desired results.

Our ties contain about 4½ cubic feet, and we propose to use about 5 gallons of oil to the tie; the length of time necessary to do this depends on the condition of dryness of the ties when treated. When quite dry, very little steam is needed, in fact it might be dispensed with; 30 minutes of exposure to superheated steam and the same length of time with an oil pressure of 20 pounds are sufficient.

But if the timber is green, 4 hours use of the steam, and 4 hours of oil pressure of 100 pounds per square inch, may not accomplish the same result. In practice, the treatment is varied within above limits, according to the condition of the timber and ascertained results after treatment. Natural seasoning is much the best, and it is considered that the saving in fuel, and cost of running the works, by reducing the time of treatment to a minimum, will more than compensate for the expense of cutting the ties, say, four months in advance, which in this climate is enough to put them in good condition. An examination of a lot of ties taken out of a cylinder after treatment will show, that while the oil consumed will average, say, 1¼ gallons to the cubic foot of timber in the cylinder, some of the ties are entirely saturated, and others have received the oil only to a certain depth from the surface, leaving the heart in its natural condition; a want of uniformity to be explained only by differences in seasoning, and differences in the grain of the wood in different trees. The latter cause is a peculiarity which will probably be found incident to every variety of timber to a greater or less extent, when exposed to this test. It is not easy to secure uniformity of treatment, for, if the pressure is continued until all of the timber in the cylinder is saturated, there will be a consumption of from 7 to 9 gallons of oil to the tie, which is much more than it is deemed necessary or profitable to use in cross-ties. It is desirable to ascertain what depth of penetration of a preservative is necessary (less than complete saturation) to insure protection.

Concerning this we have the following experience: A lot of short-leaf pine ties were treated for this company and placed in the track in 1875. They were treated in double lengths and cut in two to be used, dimensions, 7″ x 9″, 8 feet long. About ten per cent. were not treated through, and an area of from 2 to 4 inches in diameter of natural wood was thus exposed *at one end* to air and moisture. These ties are now *all* perfectly sound *where* the *wood received the oil*, but decay commenced very soon at the untreated exposed ends, and has penetrated in *at that end only* to an extent varying in length in proportion to the size of the area exposed. Where the surface was 4 inches in diameter the hollow extends 30 inches; where only one inch in diameter the decay reaches about 11 inches.

It is fair to infer that if these ties had been treated in the same manner in single lengths there would have been no decay, and the untreated parts would now be sound.

The timber has been hardened by this process, and shows as yet no serious wear. It would have been utterly worthless in two years had it not been treated.

Failures in the use of preservatives are most probably often in consequence of failure to secure the presence of the material in the wood, as it is only by frequent and careful tests while the work is going on that one can *know* the character of it, and that it is being well done.

Should you desire any further information in regard to our methods of treating timber, I shall be pleased to furnish it, as far as I can. The above is an outline only, and I have suggested some points for your consideration which I think are worthy of investigation. I will send you a treated block of the pine timber we are using.

Yours respectfully,

M. G. HOWE.

AMERICAN SOCIETY OF CIVIL ENGINEERS.

INSTITUTED 1852.

TRANSACTIONS.

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CCXLVII.

(Vol. XL.—October, 1882.)

THE KYAN PROCESS FOR PRESERVATION OF TIMBER.

ITS USE AND EFFECT AT FORT ONTARIO, NEW YORK, 1839 TO 1882.

By WILLIAM P. JUDSON, Member Am. Soc. C. E.

The following statement of the use of Kyanized timber for the revetment of the earth slopes of Fort Ontario, Oswego, New York, is prepared for the information of the American Society of Civil Engineers, with the consent of the Chief of Engineers:

Fort Ontario is situated on the south shore of Lake Ontario, and commands Oswego harbor and the mouth of the Oswego River. It was first established by the English in 1754, and has, since that date, been maintained as an important position for the defense of the Lake frontier.

Its rebuilding with Kyanized timber revetment was begun by the United States on August 5, 1839. The work was in charge of Lieutenant Danville Leadbetter, United States Corps of Engineers, who reported it as completed on September 30th, 1843.

The Kyanized timber revetments consisted of timbers twelve inches by twelve inches (12″×12″) and six inches by twelve inches (6″×12″), varying in length from thirteen and one-half (13½) to twenty-seven (27) feet, standing at a slope of two on one (2 on 1), and with an earth backing. The lower ends resting upon sills eighteen inches square (18″×18″), the upper ends capped with timbers twelve inches by eighteen inches (12″×18″).

The caps and lower sills, and a middle sill of 18″×18″ timber which was used with the longer sticks, were anchored to the earth backing by ties twelve inches square (12″×12″) and six inches by twelve inches (6″×12″), extending into it at various depths.

The entire work contained about ninety-two thousand (92 000) cubic feet of timber, equal to one million one hundred and four thousand (1 104 000) feet board measure ; all of which was subjected to the Kyan process. The details of the application of this process to Fort Ontario are taken from the reports, letters and records of the work, which were made by Lieut. Leadbetter, U. S. Corps of Engineers, during its progress, and which are now on file in the U. S. Engineer Office, Oswego, N. Y.

No copy of the original instructions is accessible. In some points of detail upon which Lieutenant Leadbetter's reports are not specific, the omissions are supplied from the records of Fort Niagara, where Captain William Smith-Frazer, Corps of Engineers, was, at the same time, using this process for a similar work.

The process was designated as " Kyan's patent for the prevention of dry-rot and the worm," and was a comparatively recent invention, having been patented in England in about the year 1832.

It was, in 1839, the property of an English company, whose agents in the United States were F. & D. Samuel, of Philadelphia.

The process consisted in immersing the timber in a solution of one pound (1lb) of corrosive sublimate ($HgCl_2$) in fifteen (15) wine gallons of water, in an open tank, for a period of time varying from fourteen (14) to twenty-one (21) days, or until the timber should be saturated. This was determined by observing a gauge within the tank, which indicated the amount of liquid absorbed.

Licenses were obtained from the agents of the patentee by Lieutenant Leadbetter and by Captain Smith-Fraser, the terms of which required that the timber should be treated in accordance with instructions fur-

nished by the company ; that the corrosive sublimate which was used should be purchased at market rates from the agents ; and that a royalty of fifty (50) cents per pound should be paid to the agents on all corrosive sublimate so purchased.

In order to immerse the timber, two tanks, each thirty (30) feet long, sixteen (16) feet wide, and four and one-half (4½) feet deep, were built of three and one-half (3½") inch seasoned pine plank, the joints being caulked inside and payed with a composition recommended by the patentee.

The planks which formed the sides, ends and bottoms, were drawn together by screw-bolts, and were then treenailed to sills and posts, which formed the outline of the tanks.

A cistern, with capacity equal to about one-third (⅓) that of a tank, and a pump, were connected with the tanks, so that the latter could be filled and emptied at will, or the solution transferred from one tank to the other if desired. It was necessary to avoid the use of iron where it would come in contact with the solution, because of its affinity for the mercury.

A crane was erected over the tanks to handle the timbers. The total cost of the plant was ($875) eight hundred and seventy-five dollars.

The timber which was treated varied in size from two (2) inch plank up to sticks eighteen (18) inches square ; the lengths varying from eight (8) feet up to twenty-nine (29) feet.

The timbers were all framed, fitted, and ready to set up, and were then placed in the tanks, where the several pieces were secured and separated by cleats in such manner as to permit the free circulation of the solution around them. Each tank would thus receive fifteen hundred and thirty-five (1 535) cubic feet of timber. The corrosive sublimate was then dissolved in hot water and poured into the cistern, and water was added in the ratio of fifteen (15) wine gallons to one pound (1lb) of corrosive sublimate. The solution was then drawn into the tank and the process repeated until the timber was submerged. Four thousand (4 000) gallons formed one charge.

After an interval of fourteen (14) to twenty-one (21) days, when the gauge showed that the timber had absorbed five hundred and seventy-four (574) gallons of solution, the remainder was pumped out of the tank, the timber was removed and was placed in a shed to dry. The 574 gallons of solution which had been absorbed contained thirty-eight and

$\frac{3}{10}$ pounds ($38\frac{3}{10}$) of corrosive sublimate, which had been received by the 1 535 cubic feet of timber. That quantity of corrosive sublimate, with a corresponding amount of water, was, therefore, restored to the solution, which was then ready for another charge.

The actual strenght of the solution was ascertained and corrected at interval by the use of a hydrometer, and by "the metallic test," whose details are not specified. No mention is made of the probable evaporation from the tanks, nor of any provision to prevent it. It is stated, however, that the solution was found to freeze at 25 degrees Fahrenheit, and that, in freezing, it rejected from the ice the corrosive sublimate, and thus increased the strength of the unfrozen portion. The workmen who were employed about the tanks became salivated, and showed the various symptoms of mercurial poisoning, so that it was necessary to relieve them frequently. Those who erected the timbers after they were dried, were much troubled by the action upon their hands and by the festers caused by slivers; and steel tools used upon the timbers speedily lost their edge.

The actual cost of treating one charge of 1 535 cubic feet of timber* was as follows, viz.:

Pro rata cost of plant, its total cost being $875	$14 58
Cost of $38\frac{3}{10}$ lbs. cor. sub. in N. Y., @ $1.35	51 70
Transportation on ditto from N. Y., @ 9 mills ℔ lb	35
Royalty on ditto, @ 50 cents ℔ lb	19 15
Labor of handling timber, etc., @ 75 cents per 10 hours	25 00
Total cost for treating 1 535 cub. ft	$110 78

Equal to seven cents two and $\frac{3}{10}$ mills (.0722) per cubic foot, or $6 per thousand feet board measure.

The actual cost of the timber, delivered on the ground, was from ($5) five dollars to seven and one-half ($7.50) per 1 000 feet board meas-

* The present cost of similar work would be as follows:

Pro rata cost of plant, its total cost being $1 750	$29 06
Cost of 38 3-10 lbs. cor. sub., @ 55c	21 00
Labor, handling timber, @ $1.50 for ten hours	50 00
Estimated total cost of treating 1 535 cub. ft	$108 06

Equal to 6.5 cents per cubic foot, or $5.42 per thousand feet board measure.

The present cost of similar timber, in its natural state, delivered on the same ground would be fifteen dollars ($15) per 1 000 ft. B. M.

ure, according to size, the average cost being $6 per 1 000 feet board measure. The expense of Kyanizing the timber was therefore just equal to its original cost.

The patentee did not recommend the use of any especial species of timber, and hemlock was chosen for the Fort Ontario work because of its cheapness. It was, on this account, used for nearly the entire work, the only exceptions being a few sticks of basswood, beech and maple, which were received among the mass of hemlock.

Under date of June 24, 1844, Lieut. Leadbetter reported regarding the work just completed: "Its appearance does not indicate the durability which was hoped to be attained by the Kyanizing process. The solution of corrosive sublimate has always been kept to the full strength and the timber has generally been immersed longer than prescribed by the directions of the patentee. None of it has been standing quite four (4) years, and, already signs of decay are exhibited on the surface of the most perishable varieties" (*i. e.*, the basswood, beech and maple referred to above). * * * * "Presuming it to be very doubtful whether the interior of sticks of a foot square was in any degree affected by the solution, I have been expecting the appearance of fungi in the sun-cracks and have not been disappointed.

"So far as I have observed, all these indications of decay are, as yet, confined to the more perishable kinds of wood, such as basswood and maple, a few sticks of which are found among the hemlock.

"But the latter, when unprepared, is not durable, and from the indications furnished by the others, this can hardly be expected to last beyond its natural duration.

"The whole of it is in contact with earth, the most unfavorable position, and the actual decay observed has been at the surface of the ground." * * * * * * * *

This quotation shows that the application of the Kyan process at Fort Ontario was then regarded as an experiment.

The merits of the method are only to be determined now, by an examination of the remaining parts of the work—forty years after its completion.

Nine-tenths ($\frac{9}{10}$) of the shorter timbers are still standing, and about two-fifths ($\frac{2}{5}$) of the upper halves of the longer timbers, with their cap timber, are still in position; the lower parts having been removed during 1863–1868, to make way for other constructions.

But enough of the timber remains to give ample evidence upon the subject in hand.

The only timbers whose lower ends now rest upon or below the surface of the ground, are the shorter ones before mentioned.

These, in general, keep their form and place perfectly, and retain the twelve or more feet of earth behind them.

But, of one hundred which were examined, all show by the presence of moss and fungi growing out of the season-cracks, that they are rotten for about six (6) feet from the surface of the ground upwards. Forty of the hundred show, by the same signs, that they are more or less rotten through their whole length; while the remaining sixty (60) appear to be entirely sound excepting the lower six (6) feet as above mentioned. At other portions of the work, where these shorter timbers have been recently heaved away from the earth behind them, and where an examination of the back of the timbers which has rested against the earth backing, is thus permitted, it is seen that the upper halves of the sixty (60) per cent. which are sound, show no material difference between the side which was toward the earth and that which was exposed to the air.

The upper halves of the longer timbers which are still in position, show a better preservation than these shorter ones, having been much dryer; eighty (80) per centum of their upper parts are sound throughout.

Of the anchor-timbers which were buried in the earth backing, the upper tier which were three (3) feet beneath the surface of the bank, were of course the best drained, and ninety (90) per cent. of them are sound. The lower tiers were more moist, and about fifty (50) per cent., only, of their exposed ends are sound. No material difference is to be observed between the preservation of the six-inch by twelve-inch (6″×12″), and of the twelve-inch square (12″×12″) timber. But the eighteen-inch square (18″×18″) middle sill shows rot much more generally, and in some parts is almost wholly gone. Its own weight and that of the timber and earth above it, being, in such cases, only supported by other constructions which have been built in front of it.

These remarks apply only to hemlock, whose open, loose grain seems to be especially well calculated to receive the solution. The only sticks of beech and maple which can now be found, are wholly rotten, except an exterior shell of about ¼-inch thickness, a portion which remains.

No pine was used in the work.

At the same time that the work at Fort Ontario was in progress, similar Kyanized revetments were also building at Fort Niagara at the mouth of the Niagara River, and at Fort Wayne, near Detroit, Michigan. Both of these works have since been rebuilt with masonry, and are in charge of this office.

The same process was used in their construction as is herein described, and the general situation of the revetments was similar to that of Fort Ontario.

This statement as to the process, therefore, applies to those works also.

At Fort Niagara, no vestige of the timber revetment remains. At Fort Wayne, the remainder of the timber revetment which is still standing is wholly of red cedar. It is generally sound and shows no evidence of having been Kyanized.

Specimens of the Fort Ontario timber, marked to indicate the portion of the work from which they are taken, are sent herewith.

SUMMARY OF RESULTS AT FORT ONTARIO: KYANIZED HEMLOCK TIMBER WITH EARTH BACKING, EXPOSED FOR FORTY (40) YEARS.

All timbers whose lower ends rest upon the surface of the ground, are rotten for (6) feet, from the foot upwards.

Above this line of general decay, forty (40) per centum are rotten enough to impair their strength, and the remaining sixty (60) per centum are sound.

Timbers which are buried in well-drained earth, which forms the upper part of a made embankment, five (5) per centum are rotten, five (5) per centum are impaired, and ninety (90) per centum are sound. Similar timbers, buried in base of same embankment, forty (40) per centum are rotten, ten per centum (10) impaired, and fifty (50) per centum sound.

Of timbers entirely above surface of ground, eighty (80) per centum of the tops are sound.

These observations apply to timbers twelve (12) inches square and smaller. Larger sizes show less favorable results.

Kyanized beech and maple timbers are rotten except a shell.

These results are shown in the following:

TABLE I.

Location in Work.	Rotten.	Impaired.	Sound.
Lower 6 feet of timbers which rest on surface of ground at the foot of slope	100 per ct.		
Upper 6 feet of the same timbers	20 "	20 per ct.	60 per ct.
Timbers buried in dry earth	5 "	5 "	90 "
" " in moist earth	40 "	10 "	50 "
Tops of timbers which are entirely above surface of ground at top of slope	10 "	10 "	80 "

The process does not increase the difficulty of working the timber after it is thoroughly dried, nor appreciably change its appearance except to make it a shade darker, and of slightly less specific gravity.

That the Kyanized timber is more rigid and is of greater transverse strength than similar timber in its natural state, is shown by the following record of tests which have just been made.

Four specimens of sound timber were taken from different parts of the work.

These were split to insure straight grain, and two sticks, each one inch square and twenty inches long, were made from each specimen. Of these, one stick from each specimen was tested; the duplicates are sent herewith. Similar specimens of timber in its natural state, cut in 1880, from the same forest as was the Kyanized timber, and two (2) years seasoned, were tested at the same time.

In testing the specimen, the stick was laid, without fastening, upon timbers which were placed twelve inches apart.

A box was hung from the centre of the specimen by the bight of a soft rope $\frac{3}{4}$-inch diameter, and the breaking weight was applied gradually, during a period of five minutes, by pouring sand into the box.

TABLE II.—Kyanized.

No. of Spec.	Location in Work for 40 Years.	Deflections at Centre in Decimals of Foot.				Breaking Weight
		100 lbs.	200 lbs.	300 lbs.	400 lbs.	
1	Upper end of timber, whose lower end rested on surface of ground and was rotten	.005	.010	.014	.023	415 lbs.
2	Exposed end of timber which was buried in dry earth	.003	.005	.008	.012	556 "
3	Upper end of timber which stood entirely above surface of ground and was sound.	.003	.005	.007	.013	467 "
4	Upper cap timber on top of No. 3	.005	.009	.012	.018	474 "
	Mean results	.004	.007	.010	.017	478 lbs.

Natural State.

No. of Spec.	Remarks.	Deflections at Centre in Decimals of Foot.				Breaking Weight
		100 lbs.	200 lbs.	300 lbs.	400 lbs.	
5		.006	.011	.016	.....	400 lbs.
6	Cut from same forest as above specimens, and seasoned for two years.	.007	.011	.015	.029	406 "
7		.004	.008	.014	.....	384 "
8		.003	.008	.012	.020	404 "
	Mean results	.005	.009	.014	.025	399 lbs.

The effects which are produced by Kyanizing seem to be the result of a chemical combination of the corrosive sublimate ($Hg\ Cl_2$) with the albuminous principle of the wood; the action being similar, in a vegetable way, to the tanning of leather.

It may be determined whether the wood is saturatd throughout, by applying hydro-sulphuret of ammonia, $S\ (N H_4)\ H$ — which turns black upon contact with the mercury.

No portion of this work at Fort Ontario was placed in a position analagous to that of an ordinary trestle, which is the sort of structure to which the process is best suited. But an examination of this work indicates that Kyanized hemlock, (and probably Canada white pine also) if set

up so that there should be a free circulation of air about it, away from contact with moist earth, and with its bases and joints so formed that water would not lodge in them, would be eighty (80) per centum sound after forty (40) years. The use of the process is not recommended for a work which will be liable to continuous moisture.

It has been suggested that the amount of corrosive sublimate could be advantageously increased by forcing a solution of greater strength into the timber, and this modification of the process would be necessary if hard wood were to be treated.

It is not, however, considered that the process would be effective against moisture under any circumstances, and the solution herein described is thought to be of ample strength for a dry situation, if the wood is thoroughly permeated by it.

A full and interesting article upon the subject of Kyan's process, may be found in the first volume of the Transactions of the Royal Engineers, showing what was originally expected from its use, and also giving some of its first results.

DISCUSSION

ON THE REPORT OF THE COMMITTEE ON THE PRESERVATION OF TIMBER,

AT THE

CONVENTION OF THE SOCIETY AT WASHINGTON, D. C., MAY 16TH, 1882.

MENDES COHEN, M. A. S. C. E.—*Mr. Chairman*,—In this discussion it is perhaps well to get at the causes of the abandonment of the preserving processes, and as I was in charge of the Lehigh and Susquehanna Railroad, upon which many Burnettized ties were laid down, and where the process continued until I found it expedient to suspend it, it seems fitting that the cause of its discontinuance should be stated.

Whilst there had not then been time enough to test the ultimate durability of the ties so treated, there had been ample opportunity to establish the fact that inferior timber, such as gum and hemlock, quite unsuitable in its natural state for cross-tie purposes, was rendered tough and serviceable, and quite available.

The abandonment of the process on this road was due entirely to the fact that the location of the yard and the disposition of the apparatus therein had ceased to be favorable for economical handling. The ties were, therefore, costing too much, and the ground was wanted for other purposes.

Under these circumstances the process was suspended for the time being, and the apparatus removed to a more convenient locality, where it was intended to arrange ample facilities.

The road passed shortly thereafter into the hands of lessees, and under the change of management the process was not resumed.

A. GOTTLIEB, M. AM. SOC. C. E.—Fifteen to twenty years ago Mr. L. B. Boomer, in Chicago, preserved the timber used in Howe trusses by the Burnettizing process. I have seen many bridges, the timber of which was treated by that process. The apparatus and manipulations were similar to those used in other processes.

A boiler or tube 60 to 80 feet long, and about 6 feet in diameter, into which the timber was run on cars; by steaming then the sap was run out of the timber, and a vacuum pump employed to accomplish it more thoroughly; then the boiler was filled with a solution of sulphate of zinc, and a high pressure applied to force it into the timber. Timbers treated this way, when left unprotected from the weather, lasted from 15 to 24 years. The Burnettizing process is a good one to a certain extent. As long as the solution remains in the timber it will protect it against rot; but the trouble is that as the sulphate of zinc is soluble in water, it is in time washed out of the timber, when left exposed to the weather, and the timber is then left in a worse condition than if it had not been treated at all. This is the only objection I have against this process.

The Thilmany process, which I know from my own observation, seems to me to improve on this point by using a double treatment.

This process treats the green timber, first in the same manner as described before, with a solution of sulphate of zinc or sulphate of copper.

After this first treatment the timber is subjected to a second treatment with a solution of chloride of barium. This solution forms with the first one in the interstices between the fibres of the wood an insoluble substance of sulphate of baryta and chloride of zinc. This process has been tried for some years in the Navy Yard in Boston for preserving timbers for the United States Navy. The Wabash, Lake Shore and Michigan Southern and New York, Pennsylvania and Ohio Railroads have used ties treated by this process for some years, and I have seen ties of all kinds of wood, as pine, beech, burr oak, hemlock and poplar in the track of the Pittsburgh and Cleveland Railroad at Cleveland, which were then about ten years in the track and perfectly sound. A stick $12'' \times 12''$—40 feet long, has been preserved by this process and cut through in the middle, and the crystals of the baryta could plainly be seen in the section.

T. EGLESTON, M. AM. SOC. C. E.—In the early days of the Union

Pacific Railway, at the time that they had built only about thirty miles, I was attached to that company as an expert, and was witness to nearly all the wonderful feats that were accomplished in the construction of that road for some months; one of these was the procuring of ties for the road previous to its reaching the base of the Rocky Mountains. These ties were made of cottonwood, in many of which a spike could be driven, but could no more be held than it could be held in a sponge.

These ties cost fifty cents apiece delivered, and if I remember correctly—for this was in the year 1864–5—it cost $1 each to preserve the ties, which were treated by the zinc process.

The works were located on the bottoms at Omaha, and the road started from Omaha on these preserved ties. It was quite possible, after the ties had been treated, to drive the spikes in such a way that they would hold. Many of these ties were used between Omaha and the Rocky Mountains, where there of course was no difficulty in getting hardwood ties at a low price.

If it had not been for this method of treating the timber, I doubt very much whether the road from Omaha to the Rocky Mountains could have been built, for I was told that the best cottonwood as useless at the end of a year. When the road reached the Rocky Mountains, I was told that all these preserved ties, which lasted, as I remember, about three years only, were taken out and replaced by hard wood.

J. B. Francis, Past President Am. Soc. C. E.—As to the effect of the corrosive sublimate used in the process of Kyanizing on the health of the workmen employed in the process, my experience has been entirely different from that stated by Mr. Judson. With a use of it commencing in 1848, and continued to this time, with an interval, I have never known a case of salivation caused by it; the workmen often get into the tanks containing the solution, with bare feet, without any injurious effects; indeed, they have an idea, whether well founded or not I am unable to say, that it heals sores; one man with sore eyes got some of the solution in them, giving much pain for a time, but it was said it cured them. I recollect only one other case where any supposed injurious effect was produced; in this case the man was engaged in dissolving the corrosive sublimate in water maintained at the boiling point in an open vessel by free steam; from breathing the escaping steam while stirring up the undissolved salt he was somewhat affected, but no serious trouble followed.

There is one important point that I think has not been fully brought out in this discussion. I refer to the preservation from rapid decay of some kinds of wood that are naturally so perishable as to be almost worthless unless treated by some antiseptic process. I have specimens of cottonwood, Kyanized nearly twenty years ago, which have been in the ground ever since, and are still sound, the wood retaining its strength and color, while other specimens, not treated, and under the same exposure, have so completely decayed as to become nothing but black mould.

I presume creosoting, and perhaps some other processes, would have been equally effective.

CLEMENS HERSCHEL, M. Am. Soc. C. E.—It is very evident that any process for preserving wood, to achieve its object, must have been well done. But beyond this, the testimony seems to show, that even when ordinary effort was made to carry out some of the processes in a good way, a portion of the timber treated did not resist decay as well as it should have done. How then are we to know whether a given stick of timber has been properly treated? I suggest that more attention be paid to finding the means of testing the amount of preservative absorbed per cubic foot of a given stick of timber.

The art of testing materials is becoming more and more an important branch of the business of the civil engineer; witness tests of iron, of cement, bricks and other substances now commonly made. Nor are we usually satisfied in these cases of iron, steel, cement, bricks, &c., with purchasing on the reputation of the manufacturer, or with having the material manufactured under inspection. "The proof of the pudding is in the eating of it," and so we test the finished product. I think this should be done in the case of treated woods. I am satisfied that were methods in general use for testing preserved or treated timber, the various processes of preserving timber would be more sought after than they now are, and that the use of treated wood, for certain purposes, would become general. I have had difficulty in finding any one, whether chemist or not, that could test wood after treatment by any process, and for this and the reasons already given, call attention to the subject.

T. EGLESTON, M. Am. Soc. C. E.—The time of the year in which wood is cut has as much to do with its strength and preservation as any other one thing. This matter has been very much neglected in this country, but a great deal of attention has been paid to it in Germany,

and it may not be without interest for me to give a short synopsis of the report presented after experiments made by that government lasting over twenty years.

They show that the season of cutting has not only to do with the present value of the wood for commercial purposes, but also with the time it will last.

Four pine trees grown on the same soil, and of the same age, were cut at the end of December, January, February and March, respectively. They were all squared with the heart in the centre, 9.42 metres by 0.157 m. by 0.131 m., and were carefully dried in the same way, and tested for flexion. That cut in December sustained the greatest weight, that cut in January sustained 12 per cent. less, that in February 20 per cent., and that in March 28 per cent. Pieces of the same age were cut in December and the last of March, and were made into posts 0.105 metres in diameter. After drying they were driven into the ground 0.94 metres. Those cut in December were good after sixteen years, those cut in March after the sap had begun to rise, broke short off after being used three years. Of pieces cut at the same time and buried in moist earth, those cut in December had some sound parts after sixteen years, those cut in March were rotten through in eight years. The same wood was used for stable flooring; that cut in December lasted six years, that cut in March was good for nothing at the end of two. Felloes and wheels were made of beech cut in December and March; those cut in December were good after sixteen years, those cut in March were worn out at seven. In order to ascertain the effect of the season upon the porosity of wood, four oaks entirely similar were cut at the end of the same four months, December, January, February and March, respectively, and at the same height above the ground. A disk was cut out of each which was 0.105 metre in thickness, and around this a rim of sheet iron 0.157 metre high was fixed and made perfectly tight. About two liters of water were poured into each of these four vessels. The vessel whose bottom was made in December allowed no water to pass; the one cut in January showed drops at the end of forty-eight hours; the one cut in February let out all the water in forty-eight hours; the one cut in March held it only two and a half hours. To decide the question of porosity still further, staves were made from oak in December and January; vessels were then made of these with the greatest care, which contained about three hektoliters each, and after drying and cleaning they were filled with new wine and

left for one year. The one cut in December lost 0.14 liters, while that cut in January lost 7.2.

It seems to be apparent from these facts that any wood which is cut for the purpose of being preserved must be cut at the season of the year when it will be most likely to retain the materials used for preserving, and thus preserve it under ordinary conditions. No attention has been paid to this matter in our own country.

There seems to be no doubt that wood cut after the sap has started has less value than that which is cut between the fall of the leaf and that time. A series of experiments ought to be made on this subject, and it is for the interest of great railroad corporations to ascertain how far the wear of their ties is affected by the time when the wood is cut.

E. R. Andrews, Assoc. M. Am. Soc. C. E.—In answer to an enquiry as to the economy of using preserved ties, Mr. Andrews said: The question of the extended use of preserved timber must be settled on the basis of true economy, *i. e.*, not first cost alone, but the cost during a term of years. If it can be shown that preserved ties at an enhanced cost will wear enough longer to pay the increase of first cost or more, the advantages of an undisturbed road-bed alone would be an urgent reason for their adoption.

The following calculations, based on the relative cost of oak ties and creosoted soft wood ties in New York at the present time, seem to me pertinent to the question, and deserve the careful consideration of engineers in charge of railroads. I assume 16 years as the probable length of life of creosoted ties, the average life stated by the engineers of the principal railways in England, where the traffic, in amount and weight, will compare with that of the roads centreing at New York, *i. e.*, almost constant.

Example—Relative cost per mile of track of oak ties, @ 80 cents, and creosoted soft wood ties, @ 90 cents each.

July 1, 1882.	Cost of 2600 creosoted soft wood cross-ties @ 90 cents each, for one mile of track.....		$2340 00
"	Compound interest at 6 per cent. for eight years (the outside life of oak ties), @ 6 per cent. per annum.....		1389 56
			3729 56
July 1, 1882.	Cost of 2600 oak ties, @ 80 cents....	$2080 00	
	Comp. int. for 8 years, @ 6 per cent.	1235 15	
			3315 15
July 1, 1890.	Cost of 2600 creosoted soft wood ties at the end of 8 years' service, already in place, and sound and good for 8 years more.....		$414 41
"	Cost of 2600 new oak ties to replace those laid in 1882, @ 80 cents each,	$2080 00	
"	Cost of transportation and relaying new ties, @ 15 cents each.....	390 00	
		$2470 00	
"	Comp. int. for 8 years @ 6 per cent.	1821 68	
		$4291 68	
"	Comp. int. on cost of creosoted ties, $414.41 for 8 years, @ 6 per cent..		246 02
July 1, 1898.	Balance in favor of creosoted soft wood ties per mile of track.....		3631 25
		$4291 68	$4291 68

If it be urged, that with the actual condition of road-beds in this country, and the severe wear to which ties are exposed in consequence of the heavy rolling stock used, creosoted ties will not *wear* 16 years, I answer:

The experience on the Central New Jersey Railroad with creosoted ties during six years under very heavy traffic is, that they are perfectly

sound and with no apparent cutting under the rails, and it is fair to assume they will be so after two years' more service, *i.e.*, a mile of track will be tied with sound, serviceable ties after eight years' service. At that time a mile of oak ties must be relaid.

The annual cost of an oak tie, at 80 cents first cost, with compound interest, is 20.6 cents, or $536.71 per mile of track. Hence, if creosoted soft wood ties will not last sixteen years, a railroad using them would realize an annual saving of $536.71 per mile of track for every year above eight during which they do wear, on a cost of $414.41. This saving is certainly worth considering.

A calculation of the relative cost of creosoted ties, at 90 cents, with oak or any other ties, which will last eight years, at 60 cents, shows a balance in favor of creosoted ties per mile of track of $843 in sixteen years; and the difference would be still larger in favor of the creosoted ties in case the untreated ties do not last eight years, as very few will. The life expected from the heart of yellow pine ties, costing 60 to 65 cents, which have been laid in large quantities during the past few years in the vicinity of New York, is only six years.

I have based these figures on the presumption that the cost of railway cross-ties will be the same eight years hence as now. But as the price of ties at New York is now at least 20 per cent. higher than five years ago, the presumption is that with the continued demand and diminished supply, the price will grow steadily higher, the saving would be even greater than the above figures indicate. In fact, oak timber is rapidly disappearing all over the country, and is now almost unattainable for ties.

The wear of creosoted ties depends certainly to a degree upon the traffic of the road. As they will not decay on small roads where the traffic is light, I fully believe they will wear from twenty-five to forty years, but under the severe traffic of trunk roads with almost constant traffic of the heaviest class, they cannot be expected to last so long, From the statement made by the engineers of the English roads (see paper by John Bogart, Trans. Am. Soc. C. E., vol. VIII, p. 18), where the traffic is almost constant; and from an examination of the ties sent by them to the Society as average ties, which had been in service from twelve to twenty-two years, it would appear, that on good roadbeds with heavy traffic in this country, preserved ties would last from twelve to twenty years.

Mr. HERSCHEL—Are creosoted ties thoroughly saturated through the heart?

Mr. ANDREWS—At a discussion on wood preservation by the Society of Arts, in London, June 1, 1860, in reply to a similar question, G. R. Burnell, F. G. S., F. S. A., said: "To be certain on that point, it would be preferable for parties wishing to apply this or any other preservative process, to entrust its execution to persons of experience and character," or, if you choose, have the work done under the supervision of your own inspector.

But to answer Mr. Herschel's question pointedly, I beg to say there is no such test. Even eyesight will not enable one to determine. Creosote oil is dark colored and stains the wood, but the coloring matter constitutes only a part of the oil, and this, being coarser, is caught in the larger or outer pores of the wood, while the lighter and possibly more effective parts penetrate deeper into the wood. Besides, no two sticks of wood, and, in fact, no two pieces from the same tree are exactly alike; hence they will absorb the oil in an unequal degree. The creosoter must not be blamed because every stick is not equally black. He undertakes to creosote timber, not to blacken it. Were it possible to completely saturate every stick, customers would not be found who would pay for it; much porous timber will readily absorb 3 gallons or 27 lbs. of oil per cubic foot, and I have injected 5 gallons. On the contrary, dense white oak can with difficulty be made to absorb 3 to 5 lbs. per cubic foot.

But, fortunately, we are not experimenting with an untried substance. For over forty years creosote has been in general use in England, and it is only fair to suppose that the quantity of oil which English engineers have settled upon as sufficient to protect timber in England, will suffice in this country, even if it does not blacken the wood through and through, *i. e.*, 7 or 8 lbs. for use in the earth, and 10 or 12 lbs. when the wood is to be exposed in the sea.

"To creosote" is simply to apply a mechanical process. Water in the wood, an obstacle to the admission of the oil, must first be removed, and then sufficient pressure must be used to force the oil in. It is unwise for engineers to demand the injection of a larger quantity of oil than the density of the wood they specify will allow. It would be wiser to specify such varieties of wood as will readily take the quantity of oil which is known to be efficacious. White oak and the heart of pitch

pine are the best for use when unpreserved, but it does not follow that they are the best for creosoting. Red oak or black oak, porous varieties, are strong enough for most purposes, when sound; creosoted they will always be sound and will last longer than white oak, because many pieces of white oak refuse the oil altogether.

Porous yellow pine, comparatively free from pitch, will drink up the oil much more freely and evenly than pitch pine, and will give a much better result, because creosote is a much better preservative than pitch; and all porous woods are cheaper than dense, indestructible varieties.